Water Audit for Jordan University Hospital

Prepared by

Water Efficiency and Public Information for Action
(WEPIA)

The Academy for Educational Development
Cooperative Agreement No. 278-A-00-00-00201-00

January 2001

Chapter 1

INTRODUCTION

OVERVIEW:

As part of WEPIA's activities in the Hashemite Kingdom of Jordan, a partnership was established with the University of Jordan through its Office of Community Services. This joint venture aims at increasing students' and faculty members' awareness of the water problem in Jordan, and helping in the identification of technical solutions to the problem. This task will be accomplished through the utilization of the student families at the University. The main objectives of the project include, but are not limited to:

- Holding a Training Course on performing water audits for large consumers.

- Training students and faculty members to conduct water audits.

- Familiarizing students and faculty members with Water Saving Devices (WSD's).

- Involving the students in a community awareness program to increase Jordanians' awareness of the water problems in Jordan, and the recommended solutions.

The "Conducting Water Audits for Large Consumers" training course was conducted at the University of Jordan's Community Services Office during the period of November 5th through November 9th, 2000. The participants in the course were from various disciplines and included; engineering consultants, maintenance technicians, university professors, water technology devices' distributors, women's groups, and students. A team comprised of the WEPIA and University of Jordan teams instructed the course. In addition, guest speakers from other agencies helped in instructing the course.

As part of the course's curriculum, a detailed water audit was conducted for the University of Jordan's Hospital. A previous study by WEPIA found the University of Jordan's Hospital to be among the top 10 large water consumers in Jordan. Since WEPIA anticipates that it is the large consumers that will significantly contribute to saving water if retrofitted, it was decided to use the Hospital as a study site for the course. The report at hand summarizes the findings of the study, presents recommendations to improve the efficiency of water usage at the University of Jordan's Hospital, and quantifies potential monetary savings shall the Hospital adopt the recommended remedial measures.

OBJECTIVE:

As mentioned earlier, the main objective of the study was to conduct a detailed water audit of the University of Jordan's Hospital. However, specific objectives include:

1. Conduct a detailed inventory of all water outlets at the study location. Those include; faucets, toilets, and showers.

2. Identify leaks and other malfunctions at those outlets.

3. Measure flow rates at the inventoried outlets, in order to estimate actual water consumption of the site.

4. Identify suitable water saving techniques (WSD's) and their applicability to the various water outlets.

5. Recommend the most qualified local suppliers capable of delivering the required technology.

6. Estimate the total cost of the retrofitting.

7. Estimate the anticipated water savings as a result of implementing water saving technology.

8. Perform cash flow analyses to demonstrate the feasibility and soundness of the retrofitting program.

REPORT OUTLINE:

The report is composed of three chapters. The first chapter gives an overview of the study. Chapter Two summarizes the raw data resulting from the water audits conducted at the site. Chapter Three presents water saving calculations as a result of the implementation of water saving technology, the cash flow calculations for the investment, and the conclusions and recommendations.

AUDIT RAW DATA

Two audits were conducted of the site over a period of one day. The study team was divided

into three groups, and each group was assigned a different part of the site. The audit took

place on November 6th, 2000. The main building was audited in the morning period, while

the out-patient clinics were audited in the afternoon period. It should be mentioned, however,

that only three of the six floors in the out-patient clinics were audited. Due to the similairty of

the different floor plans in the building, only the top, bottom and ground floors were audited,

while the data for the remaining floors was interpolated from the collected data. Tables 1

through 5 summarize the results of the audits.

UNIVERSITY HOSPITAL
Data for The Main Building

Table 1. Sinks/Faucets

Type	Location	Total	No. Leaking	Flow Rate L/min	Notes
Manual	Patients	287	0	20	2nd to 8th Floors
Manual	Staff	14	0	20	2nd to 8th Floors
Self Closed	Staff	15	5	12	Neonatal Dept.
Manual	Public	1	0	5	Gynochology Dept.
Manual	Staff	3	0	5	Gynochology Dept.
Manual	Staff	10	0		Gynochology Dept.
Manual	Staff	2	0	5.5	Gynochology Dept.
Manual	Patients	5	0	5.5	Gynochology Dept.
Manual	Patients	8	0	13	Labor Dept.
Electrical	Staff	10	5	6	Surgery
Infrared	Staff	6	0	4	Surgery
Manual	Staff	3	0	10	Surgery
Manual	Staff	5	0		Surgery (renovation)
Manual	Patients	8	0		Surgery (renovation)
Manual	Staff	3	1	28	Surgery
Manual	Staff	4	2	28	Anesthesiology Dept.
Manual	Staff	4	2	28	Surgery
Manual	Public	5	0	24	Physical Therapy
Total Faucets		**393**			

Table 2. Toilets

Type	Tank Handle	Location	Total in W.C.	No. Leaking	Tank Capacity liters	Notes
Gravity	Top Handle	P/S/V	196	0	9	2nd to 8th Floors
Gravity		Public	9	1	9	Gynochology Dept.
Gravity		Patients	4	0	9	Gynochology Dept.
Gravity		Public	15	5	12	Neonatal Dept.
Gravity		Staff	15	2	9	Surgery
Gravity		Public	2	2	9	Surgery
Gravity		Public	3	0	9	Physical Therapy
Total Toilets			**244**			

Table 3. Showers

Type	Location	Total	No. Leaking	Flow Rate l/min	Notes
Phone/Wall	Staff/Pat.	154	0	15	2nd to 8th Floors
Wall	Pateints	15	10	20	Neonatal Dept.
Manual	Pateints	8	0	24	Gynochology Dept.
Manual	Staff	6	4	24	Surgery
Manual	Pateints	5	0	20	Physical Therapy
Total Showres		**188**			

Data for The Outpatient Clinics

Table 4. Sinks/Faucets

Type	Location	Total	No. Leaking	Flow Rate l/min	Notes
Manual	Staff	73	0	20	L-2
Gear	Staff	22	0	20	L-2
Gear	Staff	6	0	9	L-2
Manual	Staff	4	0	9	L-2
Manual	Public	7	0	15	L-2
Manual	Public	4	0	14	L-2
Miscellaneous		**100**		**18**	**L-1***
Manual	Public	1	0	30	GF
Manual	Public	21	5	10	GF
Miscellaneous		**100**		**18**	**L1***
Miscellaneous		**100**		**18**	**L2***
Manual	Staff	1	0	20	L3
Manual	Staff	6	0	17	L3
Manual	Staff	19	0	24	L3
Manual	Staff	5	0	15	L3
Manual	Staff	7	0	17	L3
Manual	Staff	10	0	17	L3
Manual	Public	3	1	20	L3
Manual	Public	1	0	15	L3
Manual	Public	3	1	17	L3
Manual	Public	3	0	17	L3
Manual	Staff	9	0	15	L3
Manual	Staff	7	0	20	L3
Manual	Public	8	0	20	L3
Manual	Public	3	0	15	L3
Total Faucets		**523**			

Table 5. Toilets

Type	Tank Handle	Location	Total	No. Leaking	Tank Capacity liters	Notes
Gravity	Side	Staff	10	0	12	L-2
Gravity	Side	Public	11	0	12	L-2
Gravity	Top	Staff	2	0	12	L-2
Miscellaneous			**23**		**12**	**L-1***
Gravity	Top	Public	6	3	9	GF
Gravity	Top	Staff	1	1	9	GF
Miscellaneous			**23**		**12**	**L1***
Miscellaneous			**23**		**12**	**L2***
Gravity	Top	Public	13	6	12	L3
Gravity	Top	Staff	8	2	12	L3
Gravity	Top	Staff	2	0	9	L3
Total Toilets			**122**			

Chapter 3

WATER SAVINGS CALCULATIONS:

INTRODUCTION

In order to conduct water savings calculations as a result of installing water saving devices, certain bahvioral assumptions have to be made. Extesnive reviews of University of Jordan Hospital statistcs were conducted to arrive at the most accurate assumptions describing people's beahvior at the hospital. Generally, there are three categories of people that use water facilities at the Hospital. Those are:

1. Staff
2. Patients
3. Visitors

The following sections summarize the statistics relating to each of those three categories and the water saving calculations based on those statistics.

There are a total of 1931 employees at the Hospital. The "staff" was further sub-divided into three groups resulting in a total of five different groups among the Hospitaal populatio. The three staff sub-groups were:

- Nurses (651)
- Surgeons (50)
- Other (1230)

The maximum patient capacity of the Hospital is 508. The total number of patients at any given time was taken as 60 percent of the maximum capacity which results in an average occupancy of 305 patients at any given time during the year. In addition, Hospital statistics

revealed that the daily number of vistors is 18 visitors per bed, and the total number of visitors to the Out-Patient Clinics is 307920 visitors per year. This results in a total of 5490 patient visitors per day, and a total of Out-Patient Clinics' visitors of 6510 per day.

Each of the groups have different water consumption behaviors according to the nature of their duties. The water saving calculations were preformed for faucets, toilets, and showers. Ther results are summarized below.

Faucets:

As mentioned before, the Hospital population was divided into five groups. Table 6 summarizes the behavioral assumptions pertaining to each group.

Table 6. Faucet Usage Behavioral Assumptions

Group	Total	Frequncy of Faucet Use per Day	Duration per Use (sec)
Nurses	651	10	30
Surgeons	50	6	30
Staff	1230	3	30
Patients	305	3	120
Visitors*	3600	1	30

* only 30% of the total visitors were assumed to use a faucet once during their visit

Using the numbers above, the weigted average frequency of daily faucet use per employee is 5.4 times with a duration of 30 seconds each time the faucet is used. The frequency of daily faucet use per patient is 3 times with a frequency of 2 minutes. Finally, the frequency of daily faucet use per visitor is once with a frequency of 30 seconds. Since the average flow per

faucet is 18 liters per minute, the installation of an aerator that reduces flow to 6 liters per minute is expected to save the following amounts of water:

Staff = <u>1931 employees x (18 – 6 liters/minute) x (365 days/year) x (5.4 uses/day) x (0.5 minute/use)</u>
$$\qquad\qquad\qquad\qquad\qquad 1000 \text{ liters/m}^3$$

$\qquad = 22{,}836 \text{ m}^3$ of water saved per year

Patients = <u>305 patients x (18 – 6 liters/minute) x (365 days/year) x (3 uses/day) x (2 minute/use)</u>
$$\qquad\qquad\qquad\qquad\qquad 1000 \text{ liters/m}^3$$

$\qquad = 8{,}015 \text{ m}^3$ of water saved per year

Visitors = <u>3600 visitors x (18 – 6 liters/minute) x (365 days/year) x (1 use/day) x (0.5 minute/use)</u>
$$\qquad\qquad\qquad\qquad\qquad 1000 \text{ liters/m}^3$$

$\qquad = 7{,}884 \text{ m}^3$ of water saved per year

Therefore, the total water savings anticipated from installing faucet aerators is

$\qquad = 22{,}836 + 8{,}015 + 7{,}884 \qquad = 38{,}735 \text{ m}^3$ of water saved per year

Toilets

As mentioned before, the Hospital population was divided into five groups. Table 7 summarizes the toilet usage behavioral assumptions pertaining to each group.

Table 7. Toilet Usage Behavioral Assumptions

Group	Total	Frequncy of Toilet Use per Day
Nurses	651	1
Surgeons	50	1
Staff	1230	1

Patients	305	3
Visitors*	2400	1

* only 20% of the total visitors were assumed to use a faucet once during their visit

Since the average flow per flush is 10 liters, the installation of a water saving toilet reduces flow to 6 liters per flush which is expected to save the following amounts of water:

Staff = $\dfrac{1931 \text{ employees x } (10 - 6 \text{ liters/flush}) \text{ x } (365 \text{ days/year}) \text{ x } (1 \text{ use/day})}{1000 \text{ liters/m}^3}$

$= 2{,}241 \text{ m}^3$ of water saved per year

Patients = $\dfrac{305 \text{ patients x } (10 - 6 \text{ liters/flush}) \text{ x } (365 \text{ days/year}) \text{ x } (3 \text{ uses/day})}{1000 \text{ liters/m}^3}$

$= 1062 \text{ m}^3$ of water saved per year

Visitors = $\dfrac{2400 \text{ visitors x } (10 - 6 \text{ liters/flush}) \text{ x } (365 \text{ days/year}) \text{ x } (1 \text{ use/day})}{1000 \text{ liters/m}^3}$

$= 2{,}785 \text{ m}^3$ of water saved per year

Therefore, the total water savings anticipated from installing new water saving toilets is

$= 2{,}241 + 1{,}062 + 2{,}785 \qquad = 6{,}088 \text{ m}^3$ of water saved per year

<u>Showers:</u>

Table 8 summarizes the shower usage behavioral assumptions pertaining to each group in the Hospital population.

Table 8. Shower Usage Behavioral Assumptions

Group	Total	Frequncy of Shower Usage P	Duration per Use

		Use per Day	(min)
Nurses	651	1	8.5
Surgeons	0	0	0
Staff	100	1	8.5
Patients	305	0.2	8.5
Visitors	0	0	0

The analysis indicated that the average flow per shower head is 16.2 liters per minute, the installation of a water saving shower head that reduces flow to 9 liters per minute is expected to save the following amounts of water:

Staff = 751 employees x (16.2 – 9 liters/minute) x (365 days/year) x (1 use/day) x (8.5 minute/use)

$$\overline{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}$$

1000 liters/m^3

= 16,753 m^3 of water saved per year

Patients = 305 patients x (16.2 – 9 liters/minute) x (365 days/year) x (0.2 use/day) x (8.5 minute/use)

$$\overline{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}$$

1000 liters/m^3

= 1,362 m^3 of water saved per year

Therefore, the total water savings anticipated from installing new shower heads is:

= 16,753 + 1,362   = 18,115 m^3 of water saved per year

As a result of the proceeding calculations, the total anticipated water savings as a result of retrofiting faucets, toilets and shower heads at the Hospital is estimated at 62,938 m^3 of water per year. Urinals that consume approximately 7358 m^3/year were not included in the analysis since their water consumption can be reduced simply by increasing the time interval between automatic flushes. Also, the laundry Department which consumes a fixed 27,000 m^3 per year

was not included. Considering the Hospital's annual water consumption (146,000 m^3), such savings account for approximately 43%. According to the Ministry of Water and Irrigation's tariff, such savings are estimated at JOD 94,407 per year.

CASH FLOW ANALYSIS

Table 9 summarizes the cash flow analysis over a period of 5 years for investing in retrofiting the water fixtures at the Hospital. The following summarizes the cost of equipment:

916 faucet aerators @ JOD 2.5 Ea. =   JOD 2290

366 new toilets @ JOD 55 Ea.=   JOD 20130

189 new shower heads @ JOD 9 Ea. =   JOD 1512

Total equipment cost   =   *JOD 23,932*

Installation (10% of equipment cost) =   JOD 2393

Maintenance (5% of initial cost)   =   JOD 1196

Total Annual Expenditures   =   *JOD 1196*

Anticipated Savings   =   JOD 94,407

Annual interest rate   =   7%

Table 9. Cash Flow Analysis

Beginning of Year	Expenditures (JOD)			Total Expenditures	Saving
	Equipment	Instatllation	O+M	JOD	JOD
1	23932	2393	0	26325	0
2	0	0	1196	1196	94407
3	0	0	1196	1196	94407
4	0	0	1196	1196	94407
5	0	0	1196	1196	94407
6	0	0	1196	1196	94407

The cash flow analysis of the above amounts reveal that the Net Present Value of the investment (NPV) is approximately JOD 330,000, thus, indicating the feasibility of the investment.

CONCLUSIONS AND RECOMMENDATIONS

As can be seen in the previous section, the investment in retrofiting the various water fixtures at the University of Jordan Hospital is very feasible. The investment pay-back period is estimated at less that one year. The study team highly recommends that the Hospital's administration seriously consider the retrofiting process. Additional recommendations include:

1. Conduct detailed behavioral observational studies to validate the behavioral assumptions made in this study.

2. Concudt further analysis on the anticipated energy savings as a results of the retrofiting process.

3. An audit of the nurses dormitory is underway and should be included in the analysis.

4. Conduct audits for the floors that were not audited in the Out-patient clinics building.

APPENDIX